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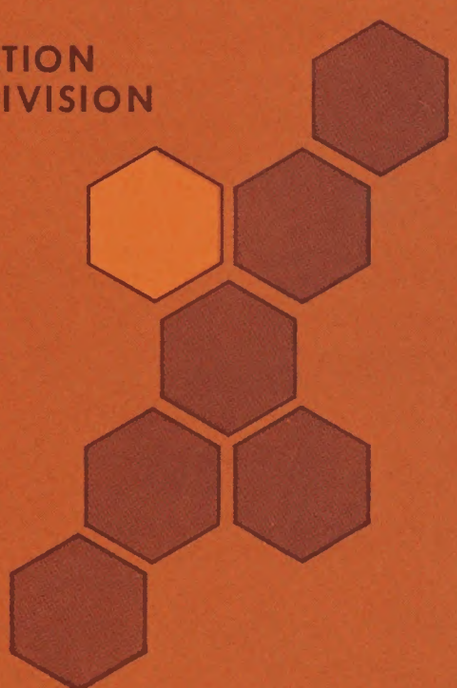
A Preliminary Study

Walter G. Heid, Jr.*

June 1971

FARM PRODUCTION
ECONOMICS DIVISION



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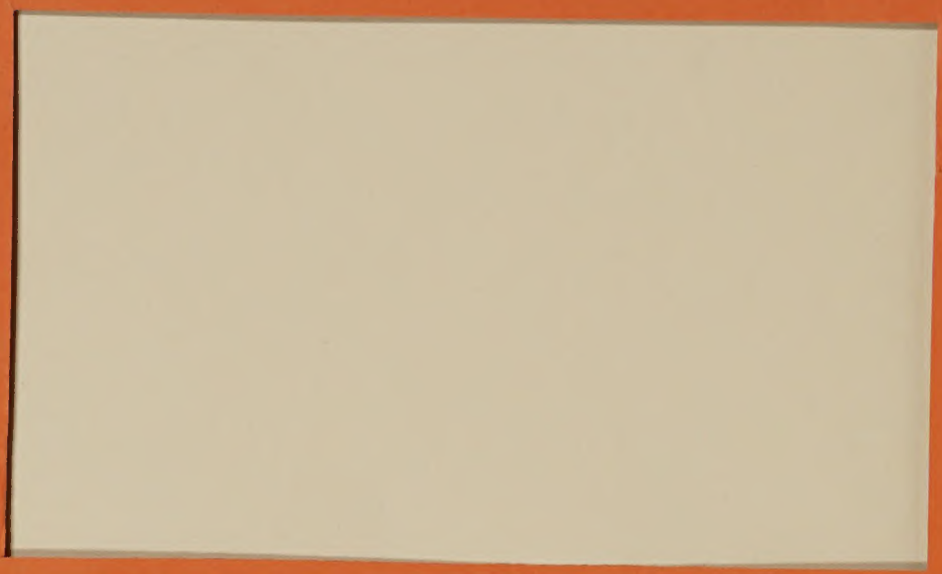

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*Agricultural Economist, Farm Production Economics Division, Economic Research Service, U. S. Department of Agriculture, Stationed at Montana State University, Bozeman, Mt 59715

Introduction

Large sized corporation farming is not new to agriculture but the extent of it and interest in it are growing. Historically farms and ranches were one of the few types of businesses that were generally small and operated as sole proprietorships. Although there were some differences in size and the amount of capital required, the input items were quite similar from farm to farm. Major differences could be explained by economies of size.

In recent years several economic forces have combined to change the structure of agriculture. Instead of farms being passed from one owner to another as a viable unit, small farms frequently become a part of a larger unit when they are sold. Some farming operations grew much faster than others. At present farming units of from 4,000 to 20,000 acres of cropland are not uncommon in the dryland wheat areas. Farms surpassing 4,000 acres of cropland are generally found to be incorporated. This alone has lead to dissimilar resource combinations.

As farms enlarge they become more like any non-farm business and farm managers become more like any other business manager. Large sized farms appear to compete more in the market place than do smaller farms. Merchandizing premiums and discounts not generally available to smaller farms are frequently obtained by large sized farms. Large farms that are managed under the corporate form of business organization tend to incur costs not common to smaller farms. A larger percentage of total costs is spent on personnel in the form of management and administration, communications and outside professional help.

Methodology

Four sizes of dryland wheat farms are budgeted in this report. Their sizes are 1,500, 3,000, 6,000 and 12,000 acres of cropland. These four sizes were selected because they represent the general range between what is presently considered a viable unit and the extent of present maximum size, with few exceptions. Each size is double the preceding size offering opportunity in budgeting to double inputs after the farm implement size was reached. For example, the largest drill in use was 48 feet and this was the size of drill used on the 6,000 acre farm. Therefore, two 48-foot drills were used on the 12,000 acre farm. All inputs could not be doubled because the proportion of all inputs do not remain constant as the agricultural firm grows. 1/

This study was based on data from three sources: (1) An ERS cost and returns survey. This study was made in 1969 when approximately 100 farms in Montana and North Dakota were surveyed. Farms ranging in size from 1,200 to 3,800 acres of cropland were studied. These data were used to construct budgets for the two smaller farm sizes included in this study. (2) Five detailed personal interviews with large sized corporation farms in Montana. These farms were as large or larger than the largest two farm sizes included in this study. Information obtained from these interviews was used to construct budgets for the two largest farm sizes. Budgets

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1/ Kenneth E. Boulding, Beyond Economics, The University of Michigan Press, 1968, pp. 75-76.

for these two sizes of farms were synthesized using the information gained from the five large corporation farms. (3) Numerous personal interviews with farm supply dealers and grain elevator managers in Montana. From these sources an estimation of the quantity discounts and pricing advantages were made. These sources provided information on both total pecuniary economies possible and volume break points. The latter were related to the four sizes of farms selected for this study.

Although the budgets in this report were prepared for the wheat enterprise, in each case the farm also had crops and livestock in addition to wheat. The degree of specialization in the semi-arid regions of the Northern Great Plains is circumscribed by topographical features. The total size of the farms studied in this report were 2,510, 5,250, 11,020 and 23,215 acres.

Very few strictly grain farms can be found especially at cropland levels of 1,500 acres and over. As farm size increases the percentage of land in crops or suited for crops decreases. About 60 percent of the land in the 1,500 cropland acre farm is suited for tillage, whereas only 52 percent of the land in the 12,000 cropland acre farm is suited for tillage, table 1.

The percentage of gross income from grain was 85, 77, 66 and 50 percent respectively from the smallest to the largest farm size. Costs not directly attributed to the grain enterprises were allocated on the basis of gross income source.

Table 1.--Land use by size of farm, Montana, 1968

Use	Size of Farm			
	1,500	3,000	6,000	12,000
Wheat	530	1,060	2,120	4,240
Barley	135	270	540	1,080
Summer fallow 1/	935	1,670	3,340	6,680
Forage	80	160	320	640
Non-cropland 2/	930	2,090	4,700	10,575
Total	2,510	5,250	11,020	23,215

1/ Includes conserving base.
2/ Includes all land pastured, waste land and farmstead acreages.

No attempt is made to optimize the production techniques assumed in this report. Farming practices and managerial decisions were taken as found and built into the farm budgets. Therefore the farms depicted in this preliminary report are representative of large dryland wheat farms in Montana, but not necessarily optimum situations.

A comparison of small farms, whether sole proprietorships or family corporations, with large incorporated farms is difficult and should be made with caution. The two types of business organizations do not function alike. Some costs incurred by large corporations are entirely uncommon to smaller farms. Other costs are incurred in considerably larger amounts. Financing may also be different as more self-financing was found in the case of large corporations. Labor and repair costs and practices differ considerably. For these reasons and others, cost items should be scrutinized closely when comparing the efficiency of the two small sized farms with the two large sized farms.

Cash costs as shown in this report are those normally appearing in schedules of the Internal Revenue Service Federal Income Tax form used by farmers.

For each acre of grain produced, approximately 1.25 acres were summer fallowed. Therefore, all per unit costs are shown for 2.25 acres, the total number of acres required to produce an acre of grain. 2/

2/ The acres of cropland needed to produce one acre of grain will vary from farm to farm, from state to state and from year to year depending on the provisions of farm programs.

Variations in production practices, wheat types and land use are great between areas in Montana and the Northern Great Plains. 3/ In this study the production of winter wheat under a summer fallow system of crop rotation similar to that found in northcentral Montana was assumed.

Throughout this report, size of farm refers to the total cropland acreage. References to farm or firm are made interchangeably. Land use by size of farm is shown in table 1.

Purpose and Objectives

Economic literature on the efficiency of large sized farms is in very short supply. Numerous empirical and analytical studies have been made but virtually none of these studies have been carried out to large farm sizes. 4/ Neither have previous studies considered pecuniary economies which exploratory research into the efficiency of large sized wheat farms has found to be of major economic consequence. 5/6/

3/ Reference is made to a study "Costs and Returns of Montana Dryland Wheat Production," by Walter G. Heid, Jr., Bul. 653, which shows major differences in wheat production practices in three separate areas in Montana.

4/ J. Patrick Madden, Economies of Size in Farming: Theory, Analytical Procedures and a Review of Selected Studies, Agr. Econ. Report 107, ERS, U.S. Department of Agriculture, February 1967.

5/ Walter G. Heid, Jr., "Pecuniary Economies and Internal Diseconomies of Large Sized Dryland Wheat Farms," paper presented at Western Agricultural Economics Association annual meetings, Corvallis, Oregon, July 1969.

6/ Pecuniary economies are advantages in buying and selling due to abilities to deal in large quantities or bargains.

The purpose of this preliminary study was to analyze the economies of large sized dryland wheat farms typical of the Northern Great Plains. The typical large sized grain farm in Montana appears to be an old farm firm, having taken roots in the 1920's or 1930's. Growth has been continual. Growth has occurred through the purchase of additional land or through land leases. Growth has also occurred through vertical integration and diversified holdings.

A limited number of interviews with corporation farms disclosed a high percentage of internal financing which would appear to give them an advantage in growth and operating strategies. Internal financing was found both in cases of operating capital needs and long term capital acquisitions. Retained earnings of well over $1 million were found. In one case long term capital was borrowed from a Federal Land Bank. In another case all the land was leased. In every case the equity position was very high.

A question may be raised as to whether the corporations interviewed in this preliminary study were typical or atypical since only old established corporations were studied. This preliminary study would indicate that growth is continual. A farm may go unnoticed until it reaches a point of expansion which marks it as a large farm. By this time in life of a progressive farm firm the equity position is high, the business is incorporated and as indicated by the very nature of the growth pattern, the management is far above average both in capacity and motivation.

Further research will be needed in Montana and other areas to determine the uniqueness of these five corporations. Whether internal financing is a function of the corporation or whether the corporation is a function of this type of financing cannot be answered at this time.

The main objective of this preliminary study was to determine the approximate shape of the long-run cost curves in dryland wheat farming, taking into account four factors associated with large sized farming: (1) Technological efficiencies, (2) Pricing advantages, (3) Quantity discounts on input purchases, and (4) Internal diseconomies accounted for by costs not common to small unincorporated farms.

Farm Characteristics

As farm size increases, a number of the practices change. These changes occur as a part of the reapportionment of resources, as management problems intensify and management capabilities increase. For example, the amount of management increased relative to other resources as farm size increased and as the need for administrative and supervisory help increased. Another example is related to custom combining. As farm size increased owner-operators no longer did their own combining because of the lack of reliable farm labor. Therefore, the percentage of grain combined by custom operator increased as farm size increased.

Machinery

The components of machinery differ greatly from farm to farm even within a given size group. For example, some sample farms in the ERS cost and returns survey had as many as four tractors while other farms of equal size had only one. In other cases small farms had large amounts and

sizes of machinery and equipment and large farms had what might be considered only a minimum both in terms of quantity and size.

Machinery costs for the four sizes of farms considered in this study are shown in Appendix A, tables 1-4. The most common set of practices found in the farm surveys were selected for each size of farm budgeted. Machinery values were based on a study by Brownson, table 2. 7/ Coefficients relating to machinery and other farming practices are shown in Appendix A.

An adjustment for quantity discounts was made to reflect pecuniary economies. 8/

Labor and Management

Some efficiency in labor utilization was found when going from the 1,500 acre farm size to the 3,000 acre farm size. However, for the larger two sizes the hours of labor hired increased more rapidly than did farm size, table 3. In every case more than a sufficient amount of hired labor was available to perform all the direct field work.

Evidence of some disproportionate resources and staff pyramiding is illustrated in figure 1. Some inefficiencies in labor use were found in the case of the largest farm size and it should be noted that this did not

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7/ Roger Brownson, "Approximate Machine Prices in Montana," Cooperative Extension Service mimeo., Montana State University, Bozeman, October 1969.

8/ On large corporation farms a large amount of machinery, not in use, was observed. No attempt was made to place a value on this machinery which ranged from new to fully depreciated items including some pieces built in on-farm shops. These items may be used as back-up equipment, alternative equipment and for parts.

Table 2.--Inventory and cost of machinery and equipment by size of farm, Montana, 1968

Machine	Unit	Size of farm: 1,500 Size	1,500 Cost	3,000 Size	3,000 Cost	6,000 Size	6,000 Cost	12,000 Size	12,000 Cost
Tractor	DBHP	88	$9,200	113	$13,000	146	$22,000	220	$42,000
Tractor	DBHP	70	3,500	84	9,000	103	11,000	103	11,000
Tractor	DBHP					80	8,800	80	8,800
Tractor	DBHP							80	8,800
Combine	Feet	16	13,900	20	16,300	22	17,400	22	17,400
Combine	Feet					20	16,300	22	17,400
Drill	Feet	22	3,800	29	4,800	48	8,400	48	8,400
Drill	Feet							48	8,400
Chisel plow	Feet	24	2,100	24	2,100	29	2,700	48	6,000
Chisel plow	Feet					24	2,100	24	2,100
Chisel ploe	Feet							20	1,800
Harrow	Feet	24	240	24	240	29	290	48	480
Harrow	Feet					24	240	24	240
Harrow	Feet							20	200
Harrow	Feet							20	200
Truck	Ton	1.5	5,000	2.0	6,100	2.0	6,100	2.0	6.100
Truck	Ton	1.5	5,000	2.0	6,100	2.0	6,100	2.0	6,100
Truck	Ton					2.0	6,100	2.0	6,100
Grain auger	Feet	31	200	41	300	41	300	41	300
Grain auger	Feet	41	300	52	400	41	300	52	400
Grain auger	Feet					52	400	52	400
Sprayer	Gal	200	700	500	1,400	500	1,400	400	1,400
Sv. truck	Ton	1.0	500	1.0	500	1.0	500	1.0	500
Sv. truck	Ton	1.0	300	1.0	500	1.0	500	1.0	500
Pickup	Ton	.5	3,600	.5	3,600	.5	3,600	.5	3,600
Pickup	Ton					.5	3,600	.5	3,600
Pickup	Ton							.5	3,600
Car 75%	Model	med	2,625	med	2,625	med	2,625	med	2,625
Cars 100%	Model					med	3,000	med	3,000
Shop tools			1,500		3,000		6,000		12,000
TOTAL VALUE			$56,465		$69,965		$129,755		$183,445
AVERAGE INVESTMENT			$30,168		$40,230		$ 74,609		$105,481
QUANTITY DISCOUNT 1/			$ 5,646		$10,495		$ 25,951		$ 43,110
TOTAL INVESTMENT			$50,819		$59,470		$103,804		$140,335
AVERAGE INVESTMENT 2/			$29,221		$34,195		$ 59,688		$ 80,692

1/ Percent quantity discount by size of farm: 1,500 acres: 10%; 3,000 acres, 15%; 6,000 acres, 20%; and 12,000 acres, 23.5%.

2/ Total investment plus salvage value divided by 2 equals average investment. Salvage value equal to 15 percent of total investment used to more nearly reflect recent trends in inflation as it has affected the value of used machinery.

Table 3.--Cropland labor and management resources, by size of farm, Montana, 1968

Item	Unit	Size of Farm 1,500	3,000	6,000	12,000
Hired labor per farm	Hrs.	1,300	1,760	5,200	15,600
Family labor per farm	Hrs.	280	1,220	--	--
Operator's labor per farm	Hrs.	2,550	2,310	--	--
Management's labor/farm	Hrs.	--	--	3,960	4,500
Total hours available	Hrs.	4,130	5,290	9,160	20,100
Total labor & management required to produce grain:					
Direct	Hrs.	1,265	2,339	3,701	5,815
Indirect	Hrs.	2,865	2,951	5,459	14,285
Total	Hrs.	4,130	5,290	9,160	20,100
Acres of Grain	Acres	665	1,330	2,660	5,320
Total hours of hired & family labor to produce grain:					
Direct	Hrs.	1,265	2,339	3,701	5,815
Indirect	Hrs.	315	641	1,499	9,785
Total	Hrs.	1,580	2,980	5,200	15,600
Total hours of hired labor to produce acre of grain:					
Direct	Hrs.	1.90	1.76	1.39	1.09
Indirect	Hrs.	.47	.48	.56	1.84
Total	Hrs.	2.37	2.24	1.95	2.93
Hired wage rate:					
Cash	Dol.	1.33	1.23	1.60	1.70
Non-cash	Dol.	.18	.28	.40	.55
Total	Dol.	1.51	1.51	2.00	2.25
Hired labor cost per acre of grain (cash & non-cash):					
Direct	Dol.	2.87	2.66	2.78	2.45
Indirect	Dol.	.71	.72	1.12	4.14
Total	Dol.	3.58	3.38	3.90	6.59

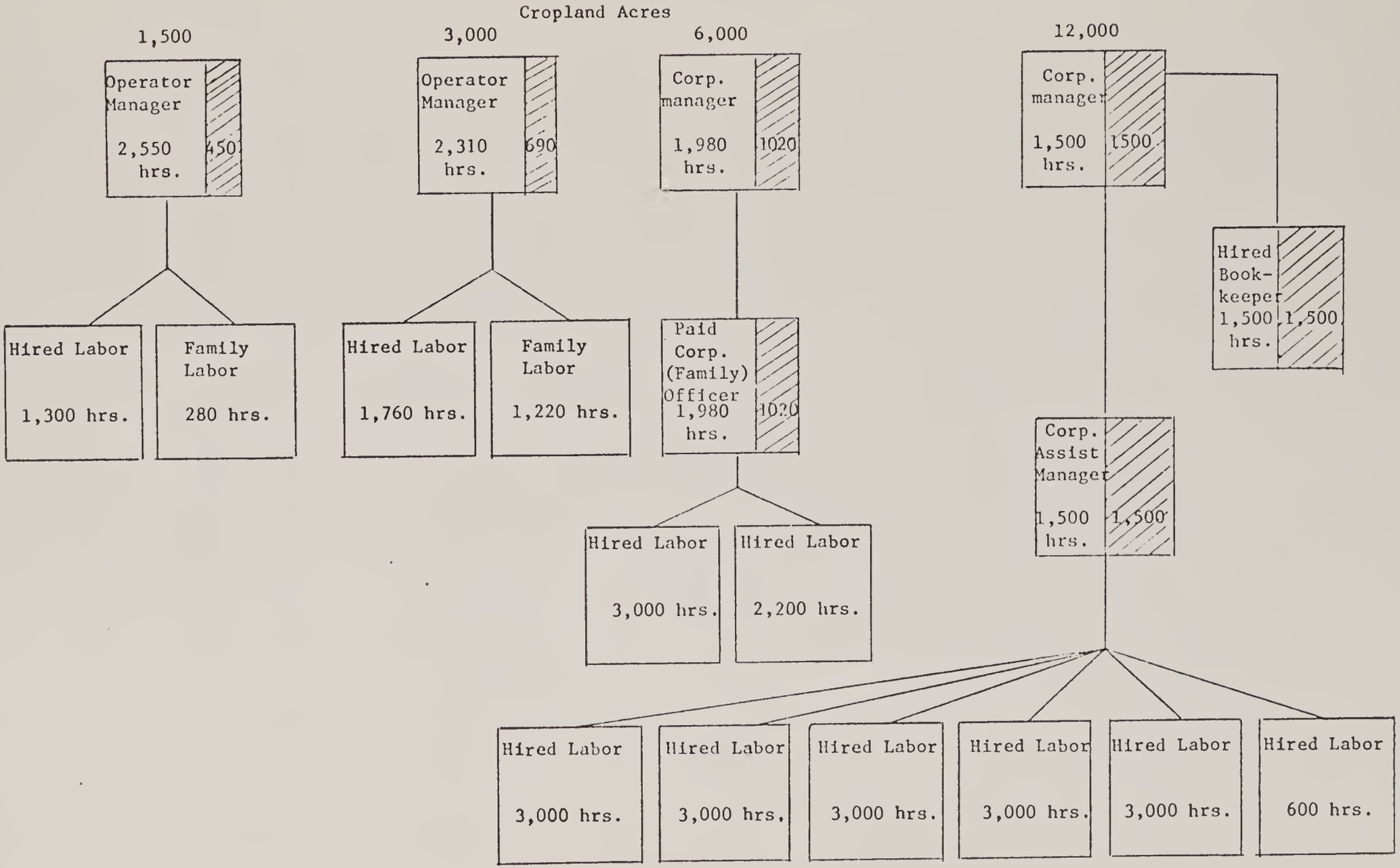

Figure 1.--Labor organizational charts by size of farm

include additional administrative and management services such as professional and legal fees and corporation charges for officers salaries and directors fees. Further research is needed to determine whether the five large sized farms were typical or atypical in their use of labor. Also various methods of allocating joint costs should be studied.

The 1,500 and 3,000 cropland acre farms function no differently than smaller family farms with respect to labor utilization. Approximately one-half year of labor was hired in each case. Generally at these size levels the management remained with the head of the household. Less than one-half a man year equivalent of family labor was hired in each case. 9/

Farms of 6,000 acres and 12,000 acres of cropland are incorporated in every case. At the 6,000 acre size management and ownership are difficu to separate because family members, in addition to the head of the household move into management positions. 10/

At this level of operation the direct production labor was generally relegated to hired labor. The management was somewhat involved in seeding and harvesting operations, and much of its time was spent in supervising help and the buying and selling activities.

9/ One man year equivalent assumed to be equal to 300 ten-hour days.

10/ In Montana it is quite common for the wife or a son to become secretary-treasurer of the family corporation.

At the 12,000 cropland acre size, ownership and management were completely separated. Management was salaried and was allowed to take advantage of certain stock options in the corporation. Management salaries for the few large farms studied generally ranged between $15,000 and $20,000 in 1969. At this size level an administrative unit consisting of one bookkeeper was established. 11/ Administrative salaries were about $6,000. Auxiliary labor was also hired. It was not uncommon at this size for positions of field supervisors, shop foremen and field maintenance men to exist. These latter positions explain the reason for over five hired positions, figure 1. 12/

Converting total hours of labor and management available into man year equivalents, the four sizes of farms employed an equivalent of 1.4, 1.8, 3.1 and 6.7 man annually, from smallest to largest size farm, respectively. Cropland acres per man equivalent were as follows: 1,500 acre farm, 1,089 acres per man; 3,000 acre farm, 1,702 acres per man; 6,000 acre farm, 1,965 acres per man; and 12,000 acre farm, 1,791 acres per man.

The efficiency of labor may be measured in several ways. In terms of cropland acres per man year the 6,000 acre farm was most efficient. 13/

11/ As farm size increases still further administrative units consisting of from 2 to 3 positions has been observed.

12/ With a large crew of farm workers it is not uncommon for meals and lodging to be provided.

13/ In terms of hired labor wage rates, the larger the farm the higher the rate. Thus, while the most efficient sized farm in terms of acres per man equivalent is the 6,000 acre farm, the most efficient in terms of labor cost per acre was the 3,000 acre farm. In terms of overall farm efficiency, low wage rates may not be beneficial either to the farm firm and are certainly not beneficial to the individuals concerned.

Marketing Distances and Patterns

From the survey data, information was available to determine distances from farmstead to field and from farm to local market, table 4. Also the percent of production that was sold on the open market versus that which was stored on-farm and later sold, could be determined. These coefficients were used to determine total truck mileages. As size of farm increased both average distance to field from farmstead and distance to local market increased. 14/

Table 4.--Marketing distances and patterns, by size of farm, Montana, 1968

Item	Unit	Size of Farm			
		1,500	3,000	6,000	12,000
Distance, round trip from:					
farmstead to field	Mi.	6	8	10	12
farm to local market	Mi.	21	26	31	36
Grain marketed at harvest time	Pct.	50	59	68	77

On-Farm Storage

Annual production is not always marketed annually. Ordinarily a percentage of each year's production is marketed at harvest time and the remainder is placed in on-farm storage. The latter is sometimes marketed

14/ The increase in distance to local market as farm size increased may be questioned. These distances may be unique to the few farms surveyed in this preliminary study. Also large farms may consider their local market a subterminal location.

prior to the next harvest and sometimes held under government loan until recalled. Approximate farm storage capacity, by size of farm, was as follows: 1,500 acre farm, one year's production; 3,000 acre farm, one year's production; 6,000 acre farm, two years' production; and 12,000 acre farm, three years' production.

For the purpose of studying the costs and returns of the four sizes of farms in this report, returns were based on the entire production for the year regardless of whether or not part of the grain was stored. The percentage reported to have been stored at harvest time was as follows: 50 percent for the 1,500 acre farm; 41 percent for the 3,000 acre farm; 32 percent for the 6,000 acre farm; and 23 percent for the 12,000 acre farm. Therefore even though the larger farm sizes had the most storage capacity relative to annual production this did not necessarily mean that more of each year's crop was placed in on-farm storage. In the case of the five large corporation farms studied much of their storage capacity was filled with grain from past seasons. 15/

The storage facilities of the large two farm sizes tended to be on the order of small to medium sized elevators with legs and truck dumps rather than the more common round steel bins. The type of storage facility is reflected in the value per bushel capacity, table 5. Capacity of size by farm is also shown in table 5.

15/ With wheat from past seasons in storage it is possible to market grain from storage, whether "free" wheat or CCC wheat, and replace it with new crop wheat. This management practice has pricing advantages. In years of high protein wheat, the premium spread is narrow and it pays to market low protein wheat at harvest time. In years of low protein wheat, the premium spread is wide and it pays to market high protein wheat at harvest time.

Table 5.--Storage capacity and current value by size of farm, Montana, 1968

Item	Unit	Size of Farm 1,500	3,000	6,000	12,000
Capacity	Bu.	25,000	50,000	150,000	500,000
Current value/bu.	Dol.	.80	.50	.55	.60
Current Value	Dol.	20,000	25,000	82,500	300,000

Sequence of Operations

The foregoing farm characteristics were combined to develop a sequence of operations for each size of farm, Appendix B, tables 1-4. The sequence of operations tables indicate the use of machinery and the time required.

Operating Costs and Investment

Costs of operation were separated into cash and non-cash costs. Cash costs are those costs that must be covered each year, table 6. Some cash costs are variable with production and some are fixed.

Non-cash costs are those costs that are charged to the operation although in any given year they may not be incurred. 16/ Non-cash costs include primarily depreciation and interest on investment and are related largely to the average current investment, table 7. The level of assumed interest on investment largely determines the magnitude of the total non-cash costs, table 8.

16/ An exception may be non-cash wages, part of which (food) is a cash expense that need, ultimately, be deducted from returns to management.

Table 6.--Cash costs by size of farm, Montana, 1968

Item	Size of Farm			
	1,500	3,000	6,000	12,000
	---Dollars/Acre of Grain---			
Labor	2.87	2.66	2.78	2.45
Seed	1.13	1.10	.98	.85
Seed cleaning & treating	.20	.19	.17	.15
Fertilizer	1.55	1.34	1.30	1.26
Herbicides, self-applied & custom	1.00	.62	.77	.98
Tractor, operating	1.64	2.36	1.91	1.40
Grain truck, operating	.24	.37	.30	.18
Equipment, operating	.96	.60	.59	.42
Combining, operating & custom 1/	1.68	3.19	4.40	5.81
Miscellaneous:				
Crop & hail insurance	1.33	1.36	1.40	1.40
Other insurance (machinery)	.35	.31	.16	.11
Utilities	.26	.20	.75	1.00
Supplies	1.19	.65	.50	.40
Legal fees			.17	.94
Directors fees				.66
Donations			.04	.04
Dues & subscriptions			.06	.03
Data processing			.13	.13
Life insurance			.50	.56
Travel			.13	.56
Telephone & telegraph			.13	.19
Other	1.28	.43	.10	.75
Indirect: 2/				
Labor	.71	.72	1.12	4.14
Fuel	1.84	1.24	1.14	.59
Repairs	1.07	.93	.93	.47
Hired management			3.72	3.85
Taxes (machinery & land)	2.08	1.90	1.88	1.79
Interest on operating capital 3/	.83	--	--	--
TOTAL	22.21	20.17	26.06	31.11

1/ Costs increase because of the ratio of custom combining to self-operated combining (see Appendix A, table 10).

2/ Costs not incurred in the direct field operations.

3/ Operators of 1,500 cropland acre model farm owned $.31 of operating capital per acre of crops. All other size models owned 100 percent of operating capital.

Table 7.--Average current investment by size of farm, Montana, 1968

Item	Unit	Size of farm 1,500	3,000	6,000	12,000
Cropland @ $150/A	Dol.	225,000	450,000	900,000	1,800,000
Grain storage	Dol.	20,000	25,000	82,500	300,000
Shop & machine sheds	Dol.	3,000	6,000	12,000	24,000
Machinery & equip.	Dol.	29,221	34,195	59,688	80,692
Total	Dol.	277,221	515,195	1,054,188	2,204,692
Investment/acre of					
cropland	Dol.	184.81	171.73	175.70	183.72
grain	Dol.	416.87	387.36	396.31	414.42

Table 8.--Non-cash costs, excluding interest on capital investment, by size of farm, Montana, 1968

Item	Size of farm 1,500	3,000	6,000	12,000
	------Dollars/Acre of Grain-------			
Depreciation:				
Machinery	6.15	3.59	3.24	2.03
Shop & machine sheds	.47	.29	.27	.18
Grain storage	1.00	.63	1.03	1.88
Sub-total	7.62	4.51	4.54	4.09
Non-cash wages	.43	.63	.78	1.61
Interest on operating				
capital owned @ 8%	.31	1.11	1.37	1.65
Sub-total	8.36	6.25	6.69	7.35
Interest on investment @:				
5 percent Dol.	20.84	19.37	19.82	20.72
6 percent Dol.	25.01	23.24	23.78	24.87
7 percent Dol.	29.18	27.12	27.74	29.01
8 percent Dol.	33.35	30.99	31.70	33.15
9 percent Dol.	37.52	34.86	35.67	37.30

Cash Costs

Cash costs tended to show economies of size as the size was increased from 1,500 to 3,000 cropland acres, table 6. Cash costs were influenced by a change in type of business operation at the 6,000 and 12,000 cropland acre levels. Diseconomies of size were found when (1) the type of business organization was changed from sole proprietorship to corporations and (2) as the size of corporation farms was increased.

Legal fees, donations, dues and subscriptions, and other miscellaneous cash costs are not itemized for the two smallest farm sizes because this information was not available. These costs, in addition to added hired field and administrative labor paid at higher rates, largely account for internal diseconomies as farm size was increased. Another cash cost that was noticeably higher for the large farms was utilities. This may be attributed to the additional residences for hired help and office space that are common to large corporation farms.

Non-Cash Costs

Included in non-cash costs are depreciation, non-cash wages, interest on operating capital and interest on investment. No attempt is made to show costs at different levels of equity.

According to the ERS cost and returns study, equity appeared to vary more within size groups than between size groups. 17/ The average ratio of equity to physical assets was found to be approximately 0.90.

17/ 1969 ERS costs and returns study conducted in Montana and northwestern North Dakota.

Therefore, for purposes of this study a debt-free situation was assumed. As a result all interest on investment was included as a non-cash cost. Non-cash costs per acre of grain are shown in table 8.

Depending on the management capabilities, the opportunity costs to farms of the sizes studied in this report appeared to range from savings accounts to the purchase of government or corporate bonds to investment in stocks. Therefore, the budgets constructed in this study assumed three levels of interest on investment, 5, 7 and 9 percent. 18/

An indication of internal diseconomies is considered one of the major findings of this preliminary study since the results shown in table 6 included most of the factors relating to quantity discounts and technological efficiencies, the exception being those discounts and efficiencies related directly to the machinery component. Continued technological efficiencies were found up through the largest farm size studied as indicated by machinery depreciation and direct field labor. Nevertheless, when all cash and non-cash costs were added together the net result was internal diseconomies as size increased. Without the offsetting advantages of quantity discounts, these diseconomies would have been even greater.

18/ It should be assumed that individuals with enough business management know-how to organize a large-sized farm would also have the know-how to invest capital at the highest possible interest rates elsewhere. Therefore, the opportunity cost to all four sizes of farms should, in reality, be at the 9 percent level since the assets of the smallest farm totalled nearly $300,000.

Pricing Advantages

If it costs more for a large farm to produce wheat than for a smaller farm, then there must be offsetting advantages, or else there would be no incentives for large sized farms to come into being. At least one offsetting advantage may be in the area of pricing. Large-sized wheat farms reported pricing advantages over small-sized farms in this preliminary study.

Prices reported by about 27 northcentral Montana farms in the ERS cost and returns study and prices reported by the 5 large corporations were used to determine the prices to use in the farm budgets. The prices received varied 39 cents per bushel on the farms sampled. The top prices were generally received by the largest farms and the lowest prices were generally received by the smallest farms sampled, figure 2. Prices received by larger farms both within and outside northcentral Montana were comparable with the top price of $1.40 per bushel shown in figure 2 for a farm with 2,010 acres of cropland.

Wheat prices used in the budgets in this report are based on these data. By size of farm budgeted, they are: 1,500 acre farm, $1.11 per bushel; 3,000 acre farm, $1.22; 6,000 acre farm , $1.43 per bushel; and 12,000 acre farm, $1.43 per bushel. 19/

19/ These prices are base prices which do not include the wheat marketing certificate which was figured at $1.38 per bushel on 40 percent of production for the 1968 wheat crop.

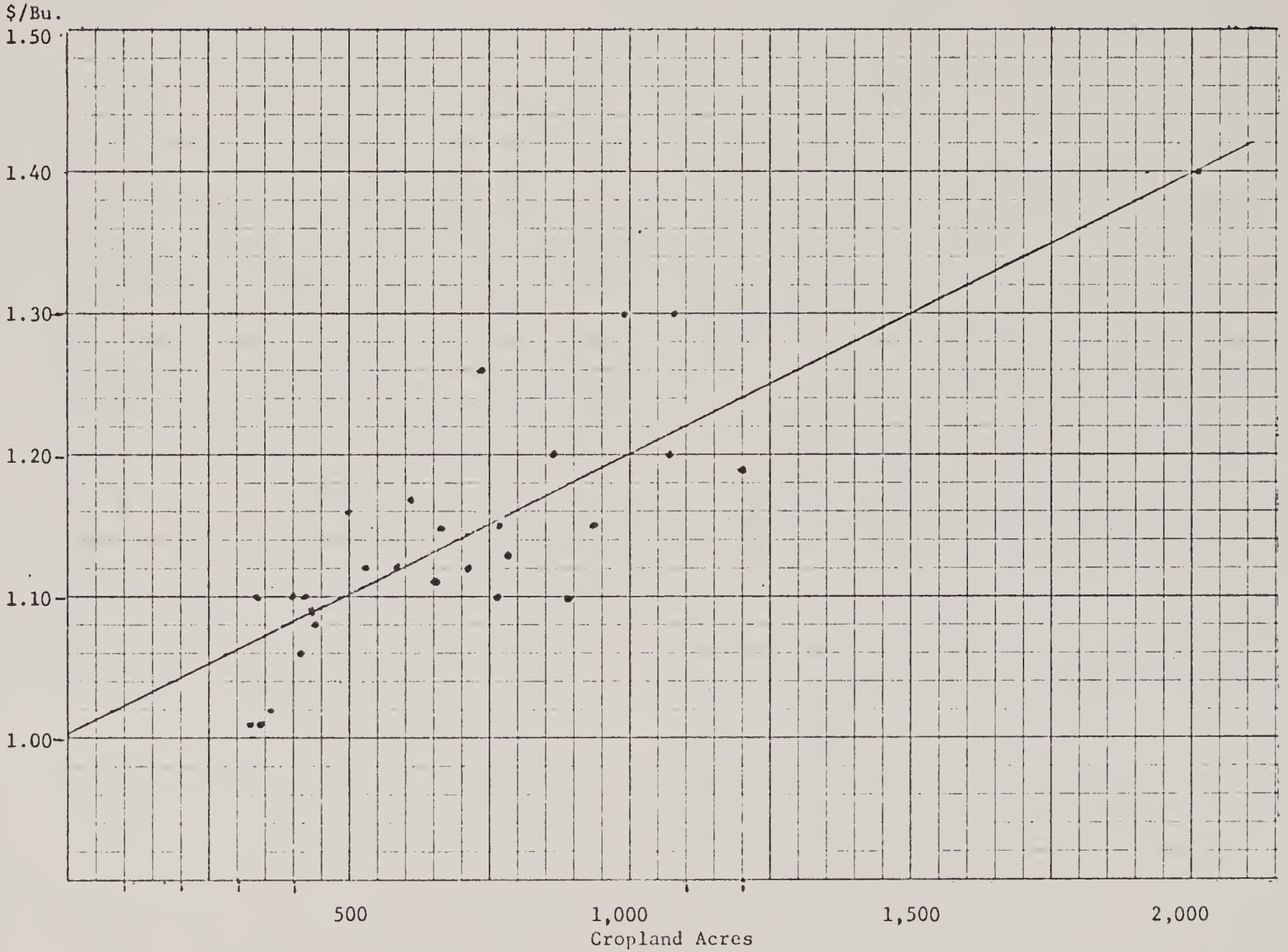

Figure 2. Linear relationship between unadjusted prices and wheat allotment acreages

These price differences were not anticipated at the onset of this study. After they were discovered, additional research was conducted to determine the reasons for these differences. Protein premiums for winter wheat, by months, were studied. Also several grain elevator managers in northcentral Montana were interviewed in search of clues to the reasons behind the reported pricing advantages. Several possible means of pricing advantages exist. Some are obtainable only by large farms, but many appeared to depend on managerial ability. The latter may or may not be tied to equity position. Further research is needed on this subject to fully determine the magnitude and latitude of pricing advantages as farm size grows.

Observations Related to Pricing Advantages

Several cases of pricing advantages were observed during the farm interviews. One respondent reported a 10-cent per bushel premium for lots of 100,000 bushels. 20/ Other large size wheat firms own local elevators. 21/ In these cases there are opportunities for maximizing joint profits. However, wheat channelled through farmer owned elevators is generally credited to the farm account at a local market price.

20/ Such premiums are believed to be rare. Elevator managers indicate that the only pricing advantages they can pass along to farmers selling large volumes are these cost savings. Generally such savings would not be 1 to 2 cents per bushel.

21/ No public elevators were considered as on-farm storage in this report.

The amount of fertilizer applied, especially nitrogen, influences protein level of wheat. Price premiums are based on protein content, table 9. Protein has been found to be nearly doubled by applying rates of nitrogen to wheat. 22/ In the cost and returns survey the protein level varied from 8 to 17 percent. The relationship between rate of fertilizer application and size of farm partially explains price advantages of large sized farms in cases where farmers used fertilizer on wheat. However, wheat was not fertilized in all farms surveyed. In addition to the effects of fertilizer on protein and in turn on price, day-to-day and even hourly fluctuations in base prices and premium prices may have affected the price-size relationship to some extent.

In an undetermined number of cases local elevators were by-passed in favor of subterminals located in the western part of the area studied. 23/ A pricing advantage of from 6 to 7 cents was reported. It would be expected that this advantage over local elevator prices would be equal to the margin of the local elevator plus transportation. This pricing advantage is a gross amount since the costs of trucking largely offset the additional price. The degree to which grain can be trucked distances of 20 to 100 miles for less cost than by rail was not determined in the study. Nevertheless, there

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22/ Experimental plots in Gallatin Valley, Gallatin County, Montana, by Dr. Paul L. Brown, Research Soil Scientist, ARS, USDA.

23/ This practice had a two-fold effect on price. First wheat was sold at a subterminal market rather than a local elevator and second, Great Falls markets are geographically nearer to the major market for Montana hard red winter wheat, the Portland-Seattle markets, resulting in lower transportation costs and thus higher prices, table 9.

Table 9.--Examples of price variations in sale of winter wheat, Montana, 1968

Time of Sale 1/		Protein Premiums 2/		Transportation 3/	
Month	Price	Protein	February	Location	Rate
	Dols.	Pct.	Dols.		Dols.
Jan.	1.26	16	.60	Power	.74
Feb.	1.27	15 1/2	.56	Ulm	.73
Mar.	1.24	15	.52	Highwood	.74
Apr.	1.20	14 1/2	.48	Great Falls	.73
May	1.19	14	.44	Belt	.75
June	1.19	13 1/2	.40	Big Sandy	.83
July	1.15	13	.36	Fort Benton	.77
Aug.	1.05	12 1/2	.30	Geraldine	.77
Sept.	1.08	12	.24	Square Butte	.77
Oct.	1.09	11 1/2	.16	Carter	.74
Nov.	1.13	11	.12	Lewistown	.78
Dec.	1.12	10 1/2 & Under	.10	Suffolk	.81 1/2

1/ Source: Prices Received and Prices Paid by Farmers and Ranchers, 1959-1968, Maurice C. Taylor, et. al., Bul. 636, Mont. Agr. Expt. Sta., Montana State University, Bozeman, March 1970.

2/ Source: Great Falls Tribune, quoted protein premiums by General Mills, Inc., mid-February, 1968. Protein levels in survey varied from 8 to 17 percent.

3/ Source: Burlington-Northern Railroad rates to north coast points (Portland-Seattle).

appear to be definite advantages to the larger sized farmer in that they own large trailer trucks. The practice of hauling grain to subterminals suggests that there may be economies of size to be gained in the hauling operations of large sized farms.

The use of rail movements directly from farm to subterminal was also observed. This method of marketing just as trucking eliminates the need for the local elevator margin. It also incurs a cost of transportation, reducing much of a reported 5-cent premium advantage for rail shipments versus truck shipments to the subterminals. This pricing advantage is unique in that it is dependent upon the location of the farm on a rail line or spur. It is largely available to large sized farms that have the volume and facilities to make rail shipments.

This pricing advantage cannot be considered seriously because, as indicated by elevator management in the area, the premium is at times for rail receipts and at times for trucked receipts. If the grain is received by rail and is immediately slated for shipment on to coastal markets it is advantageous for the subterminal to receive the grain by rail because it requires no handling. If, however, the subterminal needs trucked grain to make up shipments involving in-transit privileges then trucked grain is received at premium prices.

Location of the farm itself in relation to the markets is a big factor in price differences. However, location did not explain the relationship between size of farm and price. Prices varied by 10 cents from the subterminal market in the western part of the area studied to the local markets in the eastern part of the area.

Time of sale is another fact affecting prices received and explains part of the pricing advantage of large size farms. Average monthly prices varied from $1.05 to $1.27 in 1968, table 9. Although price varied considerably by month, large farms reported a larger percentage of wheat to be sold at harvest time than did small farms.

Some large sized farms can choose the month in which they wish to sell wheat. If more larger farms were surveyed it might be found that a much larger percentage of their production is stored at harvest time and sold later in the crop year. Elevator managers indicate that large sized farms spend considerably more time merchandising grain than do small farms. Managers of large sized farms are more aware of the quality of their grain than are managers of small farms, and approach each market in their trade area in search of the highest price. Markets to large sized farms include local elevators, subterminals, flour mills and exporters.

Financially large sized farms are able to store their grain for seasonal price advantages. Small sized farms are, in many cases, committed to short-term operating loans and must sell their grain at harvest to meet their financial obligations. Seasonal price advantages were found to be even greater than the average price per month would indicate because of the variation in protein premiums at different times of the year. 24/

24/ An undetermined amount of intercorrelation existed between monthly price differences and monthly differences in protein premiums.

Only the smallest sized farm in this report was partially subject to restriction of achieving this pricing advantage. The smaller farms surveyed in the costs and returns study were largely restricted because of financial obligations.

With proper management small farms could take advantage of most of these methods of obtaining premium prices. An adequate amount of credit is needed to fertilizer at optimum rates and to build storage capacity to handle at least a year's crop production. Adequate economic information is needed to compare seasonal prices. Adequate time is needed to study alternate markets in which grain is to be sold. Ownership of large trucks, use of rail spur lines and vertical integration into the grain elevator business are each a function of large farms.

Budget Summaries

To provide a range of investment costs, budget summaries were prepared for three interest on investment percentages, 5, 7 and 9 percent, tables 10, 11 and 12.

These budget summaries show the costs and returns per acre of wheat produced, or the costs and returns from approximately 2.25 acres. 25/ These summaries should be used to compare the economies of farm size in producing wheat rather than to compare the profitability of the farming

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25/ This assumes that the per acre costs producing all grain, wheat and barley are equal. Returns to management would be less for all grains as per acre returns from barley are less than for wheat.

Table 10.--Costs and returns of wheat by size of farm, assuming interest on investment at 5 percent, Montana, 1968

Item	Size of Farm			
	1,500	3,000	6,000	12,000
	----Dollars/Acre of Wheat-----			
Wheat, market receipts 1/	38.85	42.70	50.05	50.05
Wheat, marketing certificate 2/	19.32	19.32	19.32	19.32
Gross income 3/4/	58.17	62.02	69.37	69.37
Less: Cash expenses	22.21	20.17	26.06	31.11
Net cash income	35.96	41.85	43.31	38.26
Less: Depreciation	7.62	4.51	4,54	4.09
Non-cash wages	.43	.63	.78	1.61
Net farm income	27.91	36.71	37.99	32.56
Less: Interest on investment	20.84	19.37	19.82	20.72
Return to Management or Ownership 5/	7.07	17.34	18.17	11.84

1/ Based on prices of $1.11 for the 1,500 acre farm; $1.22 for the 3,000 acre farm; $1.43 for the 6,000 acre and 12,000 acre farms.
2/ Based on payment of $1.38 per bushel on 40 percent of production.
3/ Based on yields of 35 bushels for all farm sizes.
4/ Gross returns per acre of grain would be less because of lower gross returns per acre of barley.
5/ Return is to management and ownership in the case of the two smallest farm sizes and to ownership, only, in the case of the two largest farm sizes.

Table 11.--Costs and returns of wheat by size of farm assuming interest on investment at 7 percent, Montana, 1968

Item	Size of Farm			
	1,500	3,000	6,000	12,000
	----Dollars/Acre of Wheat----			
Wheat, receipts 1/	38.85	42.70	50.05	50.05
Wheat, marketing certificate 2/	19.32	19.32	19.32	19.32
Gross income 3/4/	58.17	62.02	69.37	69.37
Less: Cash expenses	22.21	20.17	26.06	31.11
Net cash income	35.96	41.85	43.31	38.26
Less: Depreciation	7.62	4.51	4.54	4.09
Non-cash wages	.43	.63	.78	1.61
Net farm income	27.91	36.71	37.99	32.56
Less: Interest on investment	29.18	27.12	27.74	29.01
Return to Management or Ownership 5/	(1.27)	9.59	10.25	3.55

1/ Based on prices of $1.11 for the 1,500 acre farm; $1.22 for the 3,000 acre farm; $1.43 for the 6,000 acre and 12,000 acre farms.
2/ Based on payment of $1.38 per bushel on 40 percent of production.
3/ Based on yields of 35 bushels for all farm sizes.
4/ Gross returns per acre of grain would be less because of lower gross returns per acre of barley.
5/ Return is to management and ownership in the case of the two smallest farm sizes and to ownership, only, in the case of the two largest size farms.

Table 12.--Costs and returns of wheat by size of farm, assuming interest on investment at 9 percent, Montana, 1968

Item	Size of Farm			
	1,500	3,000	6,000	12,000
	----Dollars/Acre of Wheat----			
Wheat, receipts 1/	38.85	42.70	50.05	50.05
Wheat, marketing certificate 2/	19.32	19.32	19.32	19.32
Gross income 3/4/	58.17	62.02	69.37	69.37
Less: Cash expenses	22.21	20.17	26.06	31.11
Net cash income	35.96	41.85	43.31	38.26
Less: Depreciation	7.62	4.51	4.54	4.09
Non-cash wages	.43	.63	.78	1.61
Net farm income	27.91	36.71	37.99	32.56
Less: Interest on investment	37.52	34.86	35.67	37.30
Return to Management of Ownership 5/	(9.61)	1.85	2.32	(4.74)

1/ Based on prices of $1.11 for the 1,500 acre farm; $1.22 for the 3,000 acre farm; and $1.43 for the 6,000 and 12,000 acre farms.
2/ Based on payment of $1.38 per bushel on 40 percent of production.
3/ Based on yields of 35 bushels for all farm sizes.
4/ Gross returns per acre of grain would be less because of lower gross returns per acre of barley.
5/ Return is to management and ownership in the case of the two smallest farm sizes and to ownership, only, in the case of the two largest farm sizes.

operation. Treating the wheat enterprise apart from the total farm business does not correctly reflect the pro itability of the entire farm business.

A graphic summary of these budgets is shown in figure 3. This figure illustrates that as size increases diseconomies occur and that the long-run average cost curve does, in fact, turn upward as size increases beyond the 3,000 cropland acre level. It also illustrates that as size increases pricing advantages continue to offset the internal diseconomies, until the 9 percent return on investment is assumed at the largest size level.

Long-run average total cost curves for three levels of interest on investment are shown in figure 4. The lowest points on the curves were reached at 3,000 acres of cropland. 26/ This does not imply that the 3,000 acre farm is most efficient in its overall operation.

Some key indicators which contribute to the efficiencies and inefficiencies of large sized farms are shown in table 13. Return on investment to management and ownership appears extremely low when current-day alternative investment opportunities are considered.

Of the farm sizes studied, the 3,000 acre farm had the lowest investment per acre of grain and the highest ratio of gross sales of wheat to operating expenses. The importance of the latter performance measure is its indication of general efficiency of the farming unit.

26/ The long-run average cost curve was drawn as a discontinuous function primarily because of the differences in type of business organization.

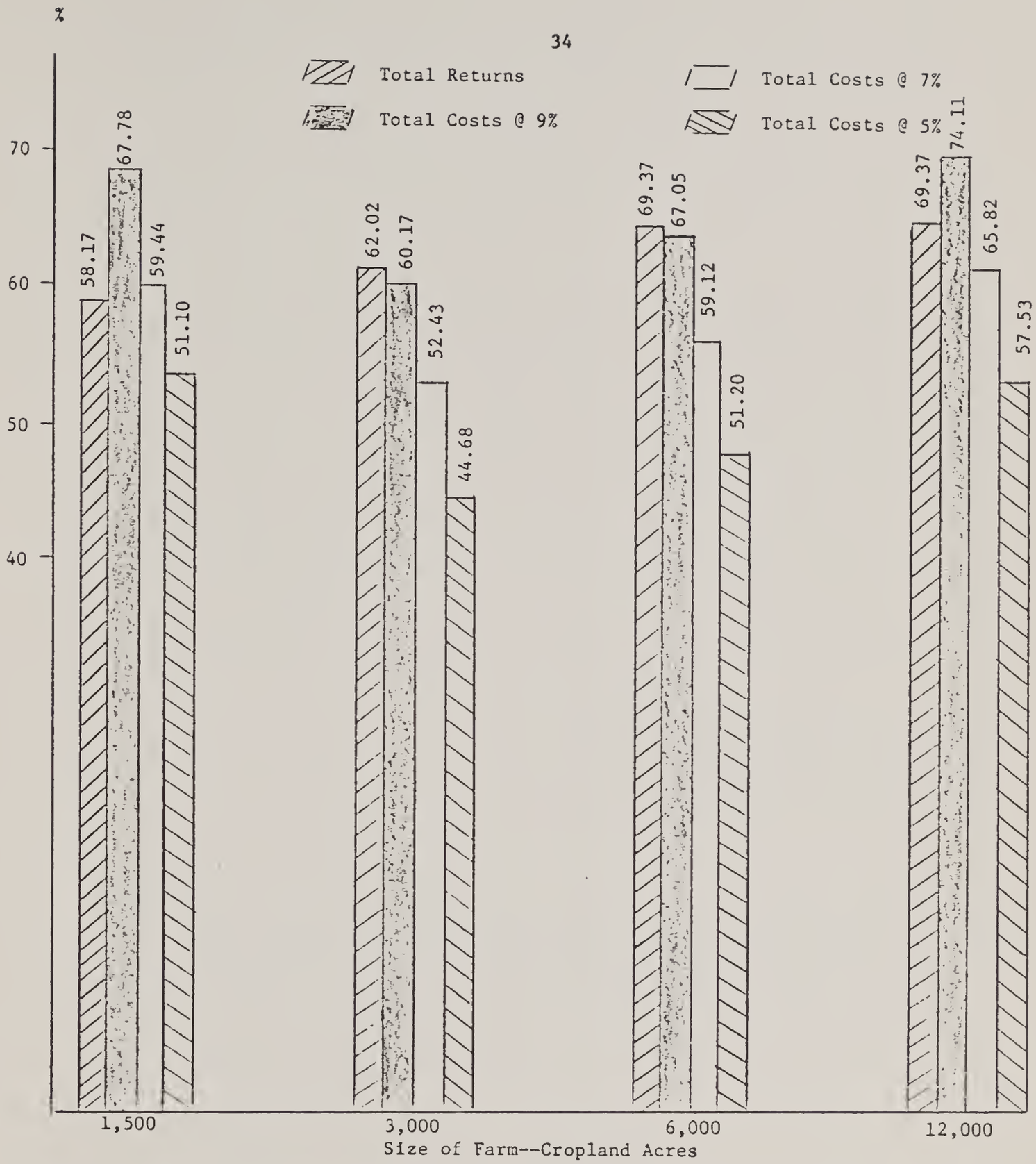

Figure 3.--Total costs and returns of wheat at varying levels of charge for interest on investment

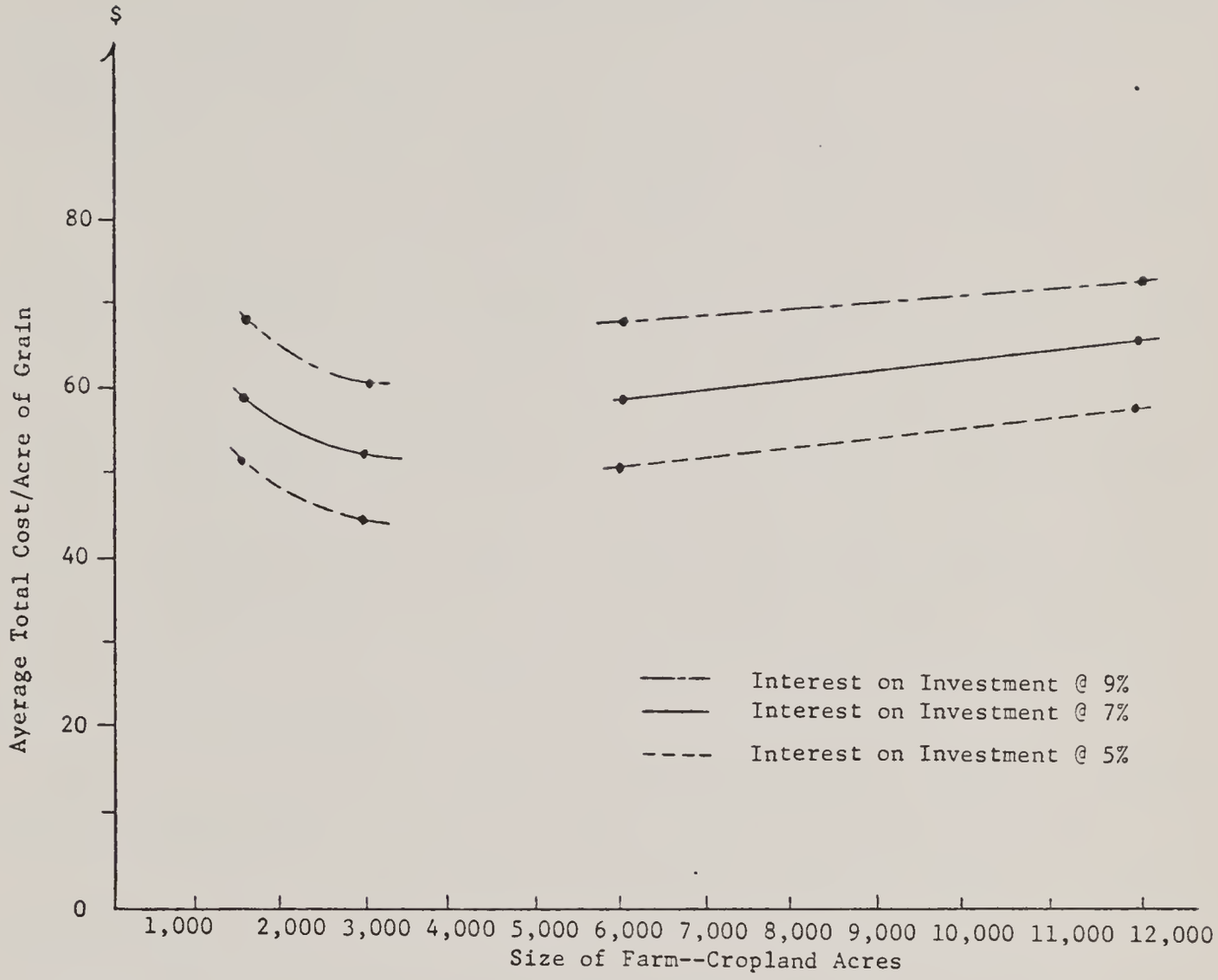

Figure 4.--Long-run average cost curves for large-sized dryland wheat farms

Table 13.--Performance measures, by size of dryland wheat farm, Montana, 1968

Item	Units	Size of Farm			
		1,500	3,000	6,000	12,000
Return to management or ownership with interest on investment at:					
5%	dol/A	1.70	4.48	4.58	2.86
7%	dol/A	-0.30	2.48	2.59	0.86
9%	dol/A	-2.30	0.48	0.59	-1.14
Return on investment to capital & management	dol/A	6.70	9.48	9.59	7.86
Investment/acre of grain	dol	416.87	387.36	396.31	414.42
Ratio of gross sales of wheat to operating expenses	dol	1:2.62	1:3.07	1:2.66	1:2.23
Hours of labor & management per acre of grain	hrs	6.21	3.98	3.44	3.78
Machine & equipment per acre of grain	dol	43.94	25.71	22.44	15.17
Storage capacity per acre of grain	bu	37.59	37.59	56.39	93.98
Bushels of wheat per dollar cash cost	bu	1.58	1.74	1.34	1.13
Bushels of wheat per dollars total cost 1/	bu	.59	.67	.59	.53

1/ Total costs include all cash costs and non-cash costs including interest on investment in land, buildings and equipment based on their current market value and figure at 7 percent.

In times of general efficiency the use of labor and management reached its peak at the 6,000 cropland acre farm level. More efficient use of machinery and equipment was found at the 12,000 cropland acre farm level. The 6,000 acre farm was the most efficient in terms of the returns to management or ownership and returns to capital and management.

Summary

Now dimensions must be added to a traditional study of economic efficiencies when large sized farms are studied. These dimensions include quantity discounts and pricing advantages. These new dimensions are sometimes referred to as pecuniary economies.

This study was commenced after concern for the "family" sized farm and the nation's food supply came to the forefront as a result of increased evidence of corporation farming.

In comparing output per unit of input the larger farms were not as efficient as the smaller farms studied. Findings of the preliminary study indicate that the right-hand side of the average total cost curve increases as (1) the type of business organization changed from a proprietorship to a corporation and (2) as size, in terms of cropland acres, was increased, despite technological efficiencies and quantity discounts received. Costs, minimal or not common to smaller family farms, were major itemized costs to large sized farm firms. Some of these costs

included legal fees, directors fees, data processing, telephone, travel, life insurance and donations. These cost items indicate a complexity and sophistication common to the business world but relatively uncommon in agriculture heretofore.

From the farm firms' standpoint, the motivation for large size appeared to stem from pricing advantages achieved in the market place. A high correlation existed between size of farm and prices received per bushel of wheat from the 1,500 acre farm to the 6,000 acre farm. Beyond the 6,000 acre farm no additional pricing advantages were found.

In conclusion several seemingly important characteristics of large sized farms were discovered in the process of this preliminary study. They include (1) apparent pricing advantages, (2) possible grain storage strategies, (3) methods of farm firm growth, (4) advantages of internal financing, (5) magnitude of quantity discounts, (6) degree of staff pyramiding and (7) apparent inefficiency of productivity.

APPENDIX A

Table 1.--Machinery costs for grain-fallow farm with 1,500 acres of cropland

Item	Depreciation	Interest	Taxes	Insurance	Housing	TFC 1/	Fuel	Lub. & Oil	Repairs	Service labor	TVC 2/	VC/A of crop 3/
	Dollars											
Tractor 88 hp	910	371	46	28	46	1,401	430	19	248	18	715	1.08
Tractor 70 hp	600	300	38	22	38	998	111	3	202	4	320	.48
Combine	1,051	580	73	44	73	1,821	97	6	375	5	483	.73
Drill	146	157	20	12	20	355	--	--	103	3	106	.16
Chisel plow	93	96	12	7	12	220	--	--	57	18	75	.11
Harrow	12	10	1	1	1	25	--	--	6	9	15	.02
Sprayer	63	25	3	2	3	96	--	--	19	2	21	.03
Grain augers (2)	56	18	2	1	2	79	--	--	14	5	19	.03
Grain trucks (2)	700	440	55	33	55	1,283	37	4	270	20	331	.50
Service trucks (2)	70	41	5	3	5	124	12	3	22	20	57	.09
Pickup	183	150	19	11	19	382	75	7	97	20	199	.30
Car	206	104	13	8	13	344	120	13	70	20	223	.34
Total	4,090	2,292	287	172	287	7,128	882	55	1,483	144	2,564	3.87

1/ TFC = total fixed cost.
2/ TVC = total variable cost.
3/ VC/A = variable cost per acre.

Table 2.--Machinery costs for grain-fallow farm with 3,000 acres of cropland

Item	Depreciation	Interest	Taxes	Insurance	Housing	TFC 1/	Fuel	Lub. & oil	Repairs	Service labor	TVC 2/	VC/A of crop 3/
	Dollars											
Tractor 113 hp	1,206	498	62	37	62	1,865	2,157	62	332	48	2,599	1.95
Tractor 84 hp	665	346	43	26	43	1,123	195	6	230	6	437	.33
Combine	1,136	654	82	49	82	2,003	163	11	416	8	598	.45
Drill	174	187	23	14	23	421	--	--	122	4	126	.09
Chisel plow	128	91	11	7	11	248	--	--	71	48	119	.09
Harrow	11	10	1	1	1	24	--	--	6	20	26	.02
Sprayer	119	48	6	4	6	183	--	--	36	2	38	.03
Grain augers (2)	74	24	3	2	3	106	--	--	18	8	26	.02
Grain trucks (2)	817	503	63	38	63	1,484	93	7	311	30	441	.33
Service trucks (2)	75	50	6	4	6	141	18	3	26	20	67	.05
Pickup	171	142	18	11	18	360	70	3	92	20	185	.14
Car	197	100	12	7	12	328	112	13	67	20	212	.16
Total	4,773	2,653	330	200	330	8,286	2,808	105	1,727	234	4,874	3.66

1/ TFC = total fixed costs.
2/ TVC = total variable costs.
3/ VC/A = variable costs per acre.

Table 3.--Machinery costs for grain-fallow farm with 6,000 acres of cropland

Item	Depreciation	Interest	Taxes	Insurance	Housing	TFC 1/	Fuel	Lub. & oil	Repairs	Service labor	TVC 2/	VC/A of crop 3/
	Dollars											
Tractor 146 hp	1,900	800	100	60	100	2,960	2,030	62	528	42	2,662	1.00
Tractor 103 hp	950	400	40	30	50	1,480	1,382	53	264	44	1,743	.66
Tractor 80 hp	804	322	40	24	40	1,230	194	7	211	8	420	.16
Combines (2)	2,196	1,278	160	96	160	3,890	268	22	809	12	1,111	.42
Drill	286	309	39	23	39	696	--	--	202	5	207	.08
Chisel plows(2)	274	198	25	15	25	537	--	--	154	86	240	.09
Harrows (2)	23	20	3	2	3	51	--	--	13	33	46	.02
Sprayer	112	45	6	3	6	172	--	--	34	2	36	.01
Grain augers (3)	100	32	4	2	4	142	--	--	24	9	33	.01
Grain trucks (3)	1,134	718	90	54	90	2,086	158	11	439	2	700	.26
Service trucks (2)	67	48	6	4	6	131	20	4	24	20	68	.03
Pickups (2)	384	270	34	20	34	742	125	13	173	40	351	.13
Cars (2)	934	202	25	15	25	661	200	25	135	40	400	.15
Total	8,624	4,642	582	348	582	14,778	4,377	197	3,010	433	8,017	3.02

1/ TFC = total fixed costs.
2/ TVC = total variable costs.
3/ VC/A = variable cost per acre.

Table 4.--Machinery costs for grain-fallow farm with 12,000 acres of cropland

Item	Depreciation	Interest	Taxes	Insurance	Housing	TFC 1/	Fuel	Lub. & oil	Repairs	Service labor	TVC 2/	VC/A of crop 3/
	Dollars											
Tractor 220 hp	3,266	1,525	191	114	191	5,287	1,756	54	964	39	2,813	.53
Tractor 103 hp	902	385	48	29	48	1,412	1,259	49	252	42	1,602	.30
Tractor 80 hp (2)	1,146	619	77	46	77	1,965	2,005	71	404	77	2,557	.48
Combines (2)	2,162	1,265	158	95	158	3,838	350	28	799	15	1,192	.22
Drills (2)	543	594	74	45	74	1,330	--	--	386	10	396	.07
Chisel plows (3)	557	383	48	29	48	1,065	--	--	227	146	373	.07
Harrows (3)	39	33	4	2	4	82	--	--	21	58	79	.01
Sprayer	107	43	5	3	5	163	--	--	32	2	34	.01
Grain augers (3)	105	34	4	3	4	150	--	--	25	8	33	.01
Grain trucks (3)	1,070	692	86	52	86	1,986	236	19	420	146	821	.15
Service trucks (2)	61	47	6	3	6	123	35	7	23	30	95	.02
Pickups (3)	451	390	49	29	49	968	188	18	248	60	514	.10
Cars (2)	374	195	24	15	24	632	200	24	129	40	393	.07
Total	10,783	6,205	774	465	774	19,001	6,029	270	3,930	673	10,902	2.04

1/ TFC = total fixed costs.
2/ TVC = total variable costs.
3/ VC/A = variable costs per acre.

Table 5.--Tractors used in wheat production, by size of farm 1/

Item	Unit	Size of Farm 1,500	3,000	6,000	12,000
Farms with 1 tractor	Pct.	100	100	100	100
Ave. DBHP of largest tractor	DBHP	88	113	146	220
Farms with 2 tractors	Pct.	63	70	83	100
Ave. DBHP of 2nd tractor	DBHP	70	84	103	103
Farms with 3 or more tractors	Pct.	15	30	60	95
Ave. DBHP of other tractors	DBHP	60	72	77	80

1/ Some farms had additional tractors that were not used in wheat production.

Table 6.--Drill characteristics by size of farm

Item	Unit	Size of Farm 1,500	3,000	6,000	12,000
Ave. width of drill	Feet	22	29	48	48
Ave. speed pulled	MPH	4.5	4.6	4.5	4.5
Cases in which another implement is pulled along with drill	Pct.	29	17	10 1/	10 1/

1/ Estimated

Table 7.--Combine characteristics by size of farm

Item	Unit	Size of Farm 1,500	3,000	6,000	12,000
Ave. width of combine	Feet	16	20	22	22
Ave. speed of combine	MPH	3.8	2.8	2.5	2.5
Farms with combines	Pct.	90	83	80	80
Farms with more than one combine	Pct.	20	30	50	90

Table 8.--Truck characteristics by size of farm

Item	Unit	Size of Farm 1,500	3,000	6,000	12,000
Trucks per farm	No.	1.7	1.9	3.0	3.0
Ave. size of trucks 1/	Tons	1.62	1.96	2.0	2.0

1/ The 1.5 ton trucks average 225 bushels of wheat per load and the 2.0 ton trucks average 300 bushels of wheat per load.

Table 9.--Herbicide practices, by size of farm

Item	Unit	Size of Farm 1,500	3,000	6,000	12,000
Farms using herbicides	Pct.	95	83	80	80
Acres of wheat sprayed	Pct.	100	90	85	80
Cost/acre custom sprayed	Dol.	1.25	1.06	1.05	1.05
Cost/acre of materials on acres sprayed by farm operator	Dol.	.60	.39	.35	.35
Pct. of acreage custom sprayed	Pct.	62	35	60	90

Table 10.--Custom combining characteristics, by size of farm

Item	Unit	Size of Farm 1,500	3,000	6,000	12,000
Charge/acre for combine & truck 1/	Dol.	5.75	6.24	6.50	6.75
Charge/acre for combine only	Dol.	4.68	4.14	4.15	4.15
Grain custom combined	Pct.	18	47	65	85

1/ The increase in charge per acre as farm size increases can be explained partially by greater distances trucked (see Appendix A, table 11).

Table 11.--Seeding practices, by size of farm

Item	Unit	Size of Farm 1,500	3,000	6,000	12,000
Seeding rate	Lbs.	60	55	52	45
Seed replanted as opposed to purchased	Pct.	100	100	100	100
Price of seed 1/	Dol.	1.13	1.13	1.13	1.13

1/ Assumes winter wheat price at market value.

Table 12.--Fertilizer practices, by size of farm

Item	Unit	Size of Farm 1,500	3,000	6,000	12,000
Farms using fertilizer	Pct.	61	75	80	85
Wheat land fertilized	Pct.	51	40	37	35
Rate of application by those fertilizing	Lbs/A	73	80	85	87
Price paid per pound	Cents	4.2	4.2	4.2	4.2
Rate of application to all crops	Lbs/A	37	32	31	30

Table 13.--Quantity discounts on fuel and oil 1/

Size of Farm	Fuel	Oil
Cropland Acres	---Percent Discount---	
1,500	10	10
3,000	15	13
6,000	20	14
12,000	30	15

1/ These discount schedules were used in determining machinery operating costs, Appendix A, tables 1-4.

APPENDIX B

Table 1.--Sequence of operations for grain-fallow farm with 1,500 acres of cropland

Sequence	Month	Implement	Width	Acres	Speed MPH	Fld eff	A/Hr	Total Hours	Total 10 hr Days	DBHP Used
Seed bed prep.	Sept	Chisel plow & harrow	20'	530	4.8	80	9.3	57.0	5.7	88
Seeding & fert.	Sept	Drill w/ fert attachment	22'	530	4.5	75	9.0	58.9	5.9	70
Hauling seed & fert to field	Sept	(4 loads x 6 mi rt* = 24 mi)						58.9	5.9	
Sv. trucks	Sept	(fuel & maintenance)						58.9	5.9	
Seed bed prep.	Apr	Chisel plow & harrow	20'	135	4.8	80	9.3	14.5	1.4	88
Seeding & fert	Apr	Drill w/ fert attachment	22'	135	4.5	75	9.0	15.0	1.5	70
Hauling seed	Apr	(2 loads x 6 mi rt = 12 mi)						15.0	1.5	
Sv. trucks	Apr	(fuel & maintenance)						15.0	1.5	
Spraying	May	Sprayer p.t.	42'	253	7.0	68	24.2	10.5	1.1	70
	May	Custom spray		412						
Summer fallow	May	Chisel plow	20'	835	4.6	80	8.9	93.8	9.4	88
Summer fallow	June	Chisel plow	22'	835	4.8	80	10.2	81.9	8.2	88
Summer fallow	July	Chisel plow w/ harrow	24'	835	4.9	80	11.4	73.2	7.3	88
Summer fallow	Aug	Chisel plow w/ harrow	24'	835	5.0	80	11.6	72.0	7.2	88
Sv. trucks	May-Aug	(fuel & maint., run by tractor operator)								
Harvest	Aug	Combine	16'	135	3.8	70	5.2	26.0	2.6	
Harvest	Aug	Combine	16'	435	3.8	70	5.2	83.7	8.4	
	Aug	Custom combine		95						
Sv. truck	Aug	(fuel & maintenance during harvest)						109.7	11.0	
Trucking grain to farm storage	Aug	(50% trucked to farm storage = 8,270 bu @ 225 bu/load = 37 loads x 6 mi rt = 222 mi)						109.7	11.0	
Trucking grain to market	Aug	(50% trucked to local mkt = 8,270 bu @ 225 bu/load = 37 loads x 21 mi rt = 777 mi)						109.7	11.0	
Auger into bins	Aug							109.7	11.0	
Hauling from farm storage to mkt	Mar	(50% later mktd = 8,270 bu @ 225 bu/load = 37 loads x 21 mi rt = 777 mi, 4 loads/day = 9.2 days)						92.0	9.2	
TOTAL								1,265.1		

*Round trip

Table 2.--Sequence of operations for grain-fallow farm with 3,000 acres of cropland

Sequence	Month	Implement	Width	Acres	Speed: MPH	Fld eff	A/Hr	Total: Hours	Total 10: Hr. Days	DBHP Used
Seed bed prep.	Sept	Chisel plow & harrow	24'	1,060	4.7	85	11.6	91.4	9.1	113
Seeding & fert.	Sept	Drill w/ fert attachment	29'	1,060	4.6	80	12.9	82.2	8.2	84
Hauling seed & fert to field	Sept	(6 loads x 8 mi rt* = 48 mi)						82.2	8.2	
Sv. trucks	Sept	(fuel & maintenance)						82.2	8.2	
Seed bed prep.	Apr	Chisel plow & harrow	24'	270	4.7	85	11.6	23.3	2.3	113
Seed & fert	Apr	Drill w/ fert attachment	29'	270	4.6	80	12.9	20.9	2.1	84
Hauling seed & fert to field	Apr	(2 loads x 8 mi rt = 16 mi)						20.9	2.1	
Sv. trucks	Apr	(fuel & maintenance)						20.9	2.1	
Spraying	May	Sprayer p.t.	42'	864	7.0	6.8	24.2	35.7	3.6	84
	May	Custom sprayed		466						
Summer fallow	May	Chisel plow	22'	1,670	4.2	85	9.5	175.8	17.6	113
Summer fallow	May-June	Chisel plow	22'	1,670	4.6	85	10.4	160.6	16.1	113
Summer fallow	June	Chisel plow	22'	1,670	4.7	85	10.7	156.1	15.6	113
Summer fallow	June-July	Chisel plow	22'	1,670	4.7	85	10.7	156.1	15.6	113
Summer fallow	July	Chisel plow & harrow	24'	1,670	4.6	85	11.4	146.5	14.6	113
Summer fallow	Aug	Chisel plow & harrow	24'	1,670	4.0	85	9.9	168.7	16.9	113
Sv. trucks	May-Aug	(fuel & maint., run by tractor operator)								
Harvest	Aug	Combine	20'	270	2.8	75	5.1	52.9	5.3	
Harvest	Aug	Combine	20'	562	2.8	75	5.1	110.2	11.0	
	Aug	Custom combined		498						
Sv. truck	Aug	(fuel & maintenance during harvest)						163.1	16.3	
Trucking grain to farm storage	Aug	(41% trucked to farm storage = 11,712 bu @ 300 bu/load = 39 loads x 8 mi rt = 312 mi)						133.8	13.4	
Trucking grain to market	Aug	(59% trucked to local mkt = 16,855 bu @ 300 bu/load = 56 loads x 26 mi rt = 1,456 mi)						192.4	19.2	
Auger into bins	Aug							163.1	86.3	
Hauling from farm storage to mkt	Mar	(41% later mktd = 11,712 bu @ 300 bu/load = 39 loads x 26 mi rt = 1,014 mi, 4 loads/day = 10 days)						100.0	10.0	
TOTAL								2,339.0		

*Round trip

Table 3.--Sequence of operations for grain-fallow farm with 6,000 acres of cropland

Sequence	Month	Implement	Width	Acres	Speed: MPH	Fld eff	A/Hr	Total Hours	Total 10 Hr. Days	DBHP Used
Seed bed prep.	Sept	Chisel plow & harrow	29'	1,220	4.6	90.0	14.6	83.6	8.4	146
Seed bed prep.	Sept	Chisel plow & harrow	24'	900	4.7	85.0	11.6	77.6	7.8	103
Seeding & fert.	Sept	Drill	48'	2,120	4.6	90.0	24.1	88.0	8.8	80
Hauling seed & fert to field	Sept	(8 loads x 10 mi rt* = 80 mi)						88.0	8.8	
Sv. trucks	Sept	(fuel & maintenance)						88.0	8.8	
Seed bed prep.	Apr	Chisel plow & harrow	29'	300	4.6	90.0	14.6	20.5	2.1	146
Seed bed prep.	Apr	Chisel plow & harrow	24'	240	4.7	85.0	11.6	20.7	2.1	103
Seeding & fert.	Apr	Drill	48'	540	4.6	90.0	24.1	22.4	2.2	80
Hauling seed	Apr	(8 loads x 10 mi rt = 80 mi)						22.4	2.2	
Sv. trucks	Apr	(fuel & maintenance)						22.4	2.2	
Spraying	May	Sprayer p.t.	42'	1,064	7.0	68.0	24.2	44.0	4.4	80
	May	Custom spray		1,596						
Summer fallow	May	Chisel plow	27'	1,840	4.0	90.0	11.8	155.9	15.6	146
			22'	1,500	4.2	85.0	9.5	157.9	15.8	103
Summer fallow	May-June	Chisel plow	27'	1,840	4.4	90.0	13.0	141.5	14.2	146
			22'	1,500	4.6	85.0	10.4	144.2	14.4	103
Summer fallow	June	Chisel plow	27'	1,840	4.5	90.0	13.3	138.3	13.8	146
			22'	1,500	4.7	85.0	10.7	140.2	14.0	103
Summer fallow	June-July	Chisel plow	29'	1,840	4.5	90.0	14.2	129.6	13.0	146
			22'	1,500	4.7	85.0	10.7	140.2	14.0	103
Summer fallow	July	Chisel plow & harrow	29'	1,840	4.4	90.0	13.9	132.4	13.2	146
			24'	1,500	4.6	85.0	11.7	128.2	12.8	103
Summer fallow	Aug	Chisel plow & harrow	29'	1,840	4.2	90.0	13.3	138.3	13.8	146
			24'	1,500	4.0	85.0	9.9	151.3	15.2	103
Sv. trucks	May-Aug	(fuel & maint., run by tractor operator)								
Harvest	Aug	Combine (barley)	22'	540	2.5	75.0	5.0	108.0	10.8	
		Combine (wheat)	22'	500	2.5	75.0	5.0	100.0	10.0	
Harvest	Aug	Combine (wheat)	20'	242	2.8	75.0	5.1	47.5	4.8	
		Custom combined		1,378						
Sv. trucks	Aug	(fuel & maint. during harvest)						208.0	20.8	

(table continued)

Table 3.--(continued)

Sequence	Month	Implement	Width	Acres	Speed MPH	Fld eff	A/Hr	Total Hours	Total 10 Hr. Days	DBHP Used
Trucking grain to farm storage	Aug	(32% trucked to farm storage = 15,222 bu @ 300 bu/load = 51 loads x 10 mi rt = 510 mi)						199.8	20.0	
Trucking grain to market	Aug	(68% trucked to local mkt = 32,348 bu @ 300 bu/load = 105 loads x 31 mi rt = 3,255 mi)						424.4	42.4	
Auger into bins	Aug							208.0	20.8	
Hauling from farm storage to mkt	Jan-Mar	(32% later mktd = 15,222 bu @ 300 bu/load = 51 loads x 31 mi rt = 1,581 mi, 4 loads/day = 13 days)						130.0	13.0	
TOTAL								3,701.3		

*Round trip

Table 4.--Sequence of operations for grain-fallow farms with 12,000 acres of cropland

Sequence	Month	Implement	Width	Acres	Speed: MPH	Fld eff	A/Hr	Total: Hours	Total 10: Hr. Days	DBHP Used
Seed bed prep.	Sept	Chisel plow & harrow	48'	3,000	5.0	90.0	26.2	114.5	11.4	220
Seed bed prep.	Sept	Chisel plow & harrow	24'	1,240	4.7	85.0	11.6	106.8	10.7	103
Seeding & fert.	Sept	Drill	48'	2,120	4.6	90.0	24.1	88.0	8.8	80
Seeding & fert.	Sept	Drill	48'	2,120	4.6	90.0	24.1	88.0	8.8	80
Hauling seed & fert to field	Sept	(16 loads x 12 mi rt* = 192 mi)						88.0	8.8	
Sv. trucks	Sept	(fuel & maintenance)						88.0	8.8	
Seed bed prep.	Apr	Chisel plow & harrow	24'	1,080	4.7	85.0	11.6	93.1	9.3	103
Seeding & fert.	Apr	Drill	48'	1,080	4.6	90.0	24.1	44.8	4.5	80
Hauling seed & fert to field	Apr	(6 loads x 12 mi rt = 72 mi)						44.8	4.5	
Sv. trucks	Apr	(fuel & maintenance)						44.8	4.5	
Spraying	May	Sprayer, p.t.	42'	532	7.0	68.0	24.2	22.0	2.2	80
	May	Custom spray		4,788						
Summer fallow	May	Chisel plow	48'	3,080	4.5	90.0	23.6	130.5		220
	May	Chisel plow	24'	1,300	4.2	85.0	10.4	125.0		103
	May	Chisel plow	20'	1,100	4.5	80.0	8.7	126.4		80
	May	Chisel plow	20'	1,100	4.5	80.0	8.7	126.4		80
	May-June	Chisel plow	48'	3,080	4.7	90.0	24.6	125.2		220
	May-June	Chisel plow	24'	1,300	4.3	85.0	10.6	122.6		103
	May-June	Chisel plow	20'	1,100	4.7	80.0	9.1	120.9		80
	May-June	Chisel plow	20'	1,100	4.7	80.0	9.1	120.9		80
	June	Chisel plow	48'	3,080	4.8	90.0	25.1	122.7		220
	June	Chisel plow	24'	1,300	4.4	85.0	10.9	119.3		103
	June	Chisel plow	20'	1,100	4.8	80.0	9.3	118.3		80
	June	Chisel plow	20'	1,100	4.8	80.0	9.3	118.3		80
	June-July	Chisel plow	48'	3,080	5.0	90.0	26.2	117.6		220
	June-July	Chisel plow	24'	1,300	4.5	85.0	11.1	117.1		103
	June-July	Chisel plow	20'	1,100	5.0	80.0	9.7	113.4		80
	June-July	Chisel plow	20'	1,100	5.0	80.0	9.7	113.4		80
	July	Chisel plow & harrow	48'	3,080	4.8	90.0	25.1	122.7		220
	July	Chisel plow & harrow	24'	1,300	4.4	85.0	10.9	119.3		103
	July	Chisel plow & harrow	20'	1,100	4.8	80.0	9.3	118.3		80
	July	Chisel plow & harrow	20'	1,100	4.8	80.0	9.3	118.3		80

(table continued)

Table 4.--(continued)

Sequence	Month	Implement	Width	Acres	Speed: MPH	Fld eff:	A/Hr	Total: Hours	Total 10: Hr. Days	DBHP Used
Summer fallow	Aug	Chisel plow & harrow	48'	3,080	4.6	90.0	24.1	127.8		220
	Aug	Chisel plow & harrow	24'	1,300	4.3	85.0	10.6	122.6		103
	Aug	Chisel plow & harrow	20'	1,100	4.6	80.0	8.9	123.6		80
	Aug	Chisel plow & harrow	20'	1,100	4.6	80.0	8.9	123.6		80
Sv. trucks	May-Aug	(fuel & maintenance)						746.5		
Harvest	Aug	Combine (barley)	22'	540	2.5	75.0	5.0	108.0	10.8	
	Aug	Combine (barley)	22'	540	2.5	75.0	5.0	108.0	10.8	
Harvest	Aug	Combine (wheat)	22'	318	2.5	75.0	5.0	63.6	6.4	
	Aug	Combine (wheat)	22'	318	2.5	75.0	5.0	63.6	6.4	
	Aug	Custom combine		3,604						
Sv. trucks	Aug	(fuel & maintenance)						171.6	17.2	
Trucking grain to farm storage	Aug	(23% trucked to farm storage = 15,056 bu @ 300 bu/load = 51 loads x 12 mi rt = 612 mi)						118.5	11.8	
Trucking grain to market	Aug	(77% trucked to local mkt = 50,404 bu @ 300 bu/load = 168 loads x 36 mi rt = 6,048 mi)						396.3	39.6	
Auger into bins	Aug							171.6	17.2	
Hauling from farm storage to market	Jan-Mar	(23% later mktd = 15,056 bu @ 300 bu/load = 51 loads x 36 mi rt = 1,836 mi, 4 loads/day = 13 days)						130.0	13.0	
TOTAL								5,814.7		

*Round trip

APPENDIX C

Table 1.--Summary of linear regression analysis of price-size relationship

Item	Unadjusted Price	Price Adjusted for Location	Price Adjusted for Time of Sale	Price Adjusted for Protein
Mean of X	708.964	708.964	708.964	708.964
Mean of Y	114.643	117.786	113.179	100.786
Y-Intercept	100.480	104.036	103.179	100.082
b	.0199764	.0193938	.0141051	.0009922
R	.827919	.780306	.509499	.030838
R_2	.68545	.608877	.25959	.000951